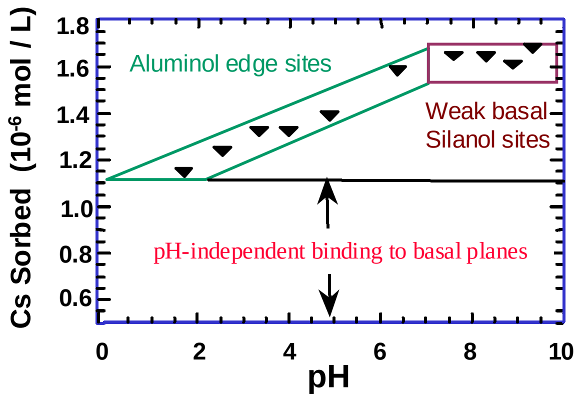
Low Temperature Fluid-Mineral Interactions

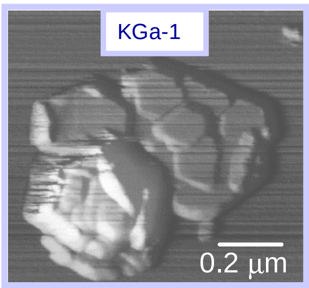
Description

Low temperature geochemical processes are dominated by aqueous fluid-mineral interactions. A mechanistic understanding of those interfacial processes and measurement of their kinetic parameters are based on complementary experimental, analytical, and theoretical studies. Experimental studies often employ simple, but well constrained, measurements of surface area, surface charge, sorption isotherms, and dissolution and precipitation rates using synthetic or natural mineral samples. Theoretical efforts use a combination of thermochemical calculations, surface complexation models, and molecular modeling tools to interpret complex mechanisms and energetics (e.g., multi-site sorption isotherms and enthalpies). Characterization of solid and liquid samples utilize multiple analytic instruments, depending upon whether it is a bulk or surface analysis, or a structural or a chemical analyis. A few of these analytic techniques include:

- Direct current plasma spectroscopy (DCP)
- Ion chromatography (IC)
- X-Ray diffraction (XRD)
- Ion specific electrode (ISE; e.g., pH titrator)
- Scanning / transmission electron microscopy (SEM / TEM)
- Energy dispersive spectrometry (EDS)
- Secondary ion mass spectrometry (SIMS)
- Nuclear magnetic resonance spectroscopy (NMR)
- Atomic force microscopy (AFM)

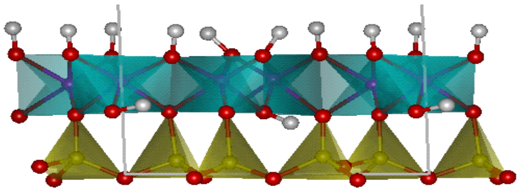


Cs Sorption on Kaolinite at 50° C



AFM Characterization of Kaolinite

Edge area vs. Total surface areas

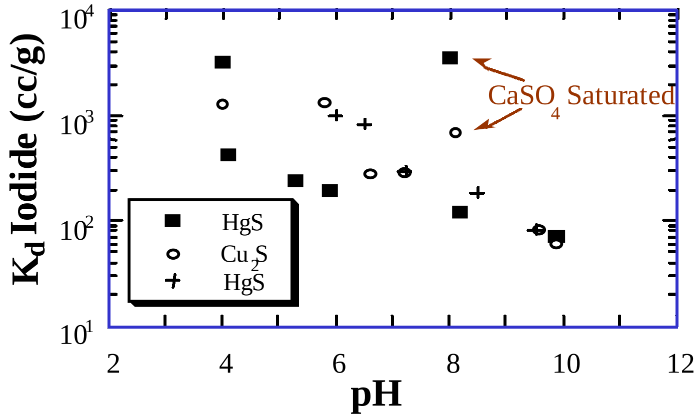


Molecular Modeling of Kaolinite

(100) View of Clay Structure

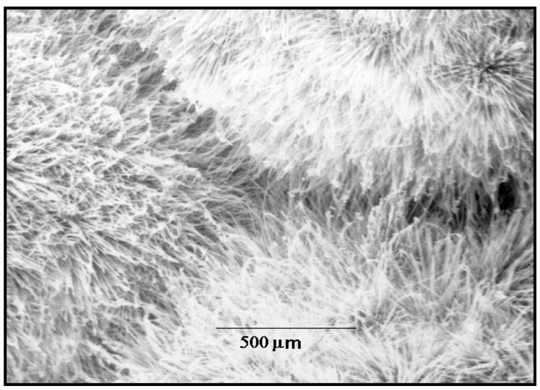
Needs

- Bulk mineral phase and structure identification
- Characterization of surface chemistry and anmorphology
- Metal ion sorption / desorption kinetics
- Ion sequestration mechanisms
- Reactivity of mineral-solution interfaces
- Precipitation and dissolution reactions and kinetics



Radionuclide Getter Materials

Measurement of I- sorption onto sulfide minerals to inhibit migration of problem radionuclides, including Tc, Se, and actinides sorbed on oxide and silicate mineral surfaces

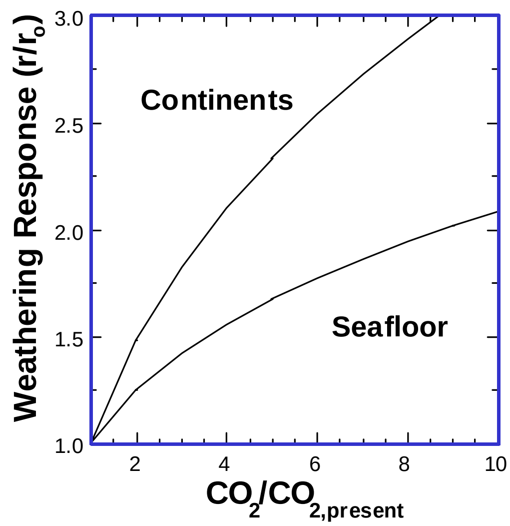


Reactivity and Kinetics of Backfill Materials

SEM photo of MgO pellets after reaction with WIPP brine to form strength-enhancing sorel cement; studies include measurement of hydration rates and phase chemistry of MgO as well as ordinary Portland cement

Global Carbon Cycle

Seafloor weathering of abyssal basalts (lab dissolution experiments) helps control long-term climate, although the feedback is not as strong as terrestrial weathering (field weathering rates)



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